

# RESEARCH

IN SCIENCE JOURNALS

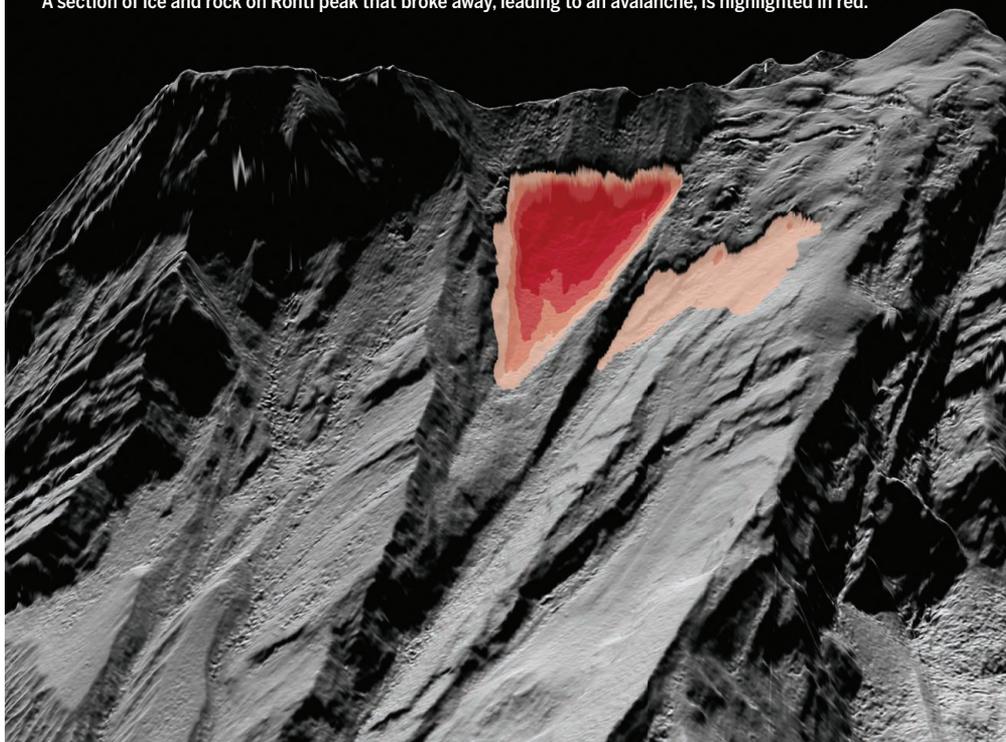
Edited by Michael Funk

## NATURAL HAZARDS

### A deadly cascade

**A** catastrophic landslide in Uttarakhand state in India on February 2021 damaged two hydropower plants, and more than 200 people were killed or are missing. Shugar *et al.* describe the cascade of events that led to this disaster. A massive rock and ice avalanche roared down a Himalayan valley, turning into a deadly debris flow upstream from the first of the two hydropower plants. The sequence of events highlights the increasing risk in the Himalayas caused by increased warming and development. —BG *Science*, abh4455, this issue p. 300

A section of ice and rock on Ronti peak that broke away, leading to an avalanche, is highlighted in red.



## CHROMATIN

### Chromatin landscape dictates remodeling

Large, multicomponent molecular machines known as mammalian SWI/SNF (mSWI/SNF) chromatin-remodeling complexes play critical roles in governing the architecture of our genomes. These entities bind to chromatin (DNA assembled on proteins) inside the nucleus and dictate which regions of DNA, and thus

which genes in our genome, are made accessible. It is critical that this process happens at the right times and for the right genes in cells, because disruptions cause diseases such as cancers and neurodevelopmental disorders. Mashtalir *et al.* uncovered molecular cues that direct complex activities on chromatin, informing specific interactions that may be amenable to therapeutic targeting. This combinatorial approach, which considers many factors

involved in determining mSWI/SNF activity, provides a valuable resource for understanding the binding and activity of chromatin-remodeling complexes. —DJ

*Science*, abf8705, this issue p. 306

## GAS SEPARATION

### Channeling carbon dioxide

The separation of gas molecules with physisorbents can

be challenging because there is often a tradeoff between capacity and selectivity. Zhou *et al.* report a template-free hydrothermal synthesis of the one-dimensional channel zeolite mordenite, in which some silicon was replaced by iron. Rather than forming a powder that requires further shaping, this mechanically stable material self-assembled into monoliths. Iron atoms bound in tetrahedral zeolite sites narrowed the channels and enabled the size-exclusion separation of carbon dioxide (CO<sub>2</sub>) over nitrogen (N<sub>2</sub>) and methane. High CO<sub>2</sub> uptake and highly efficient CO<sub>2</sub>-N<sub>2</sub> separation was demonstrated for both dry and humid conditions. —PDS

*Science*, aax5776, this issue p. 315

## MATERIALS SCIENCE

### Autonomous self-healing

The ability to autonomously restore shape or self-heal are useful properties that have been incorporated into a range of materials, including metals and polymers. Bhunia *et al.* found that both of these abilities could be achieved in piezoelectric bipolar crystals, specifically bipyrazole organic crystals. When the crystals are fractured, they develop charged surfaces that attract each other, drawing the two faces together to enable self-repair as long as they remain within a critical distance of each other. The effect can also be seen in other non-centrosymmetric piezoelectric crystals. —MSL

*Science*, abg3886, this issue p. 321

## OXIDE ELECTRONICS

### A transient metal

Vanadium dioxide is known to have a coupled structural and electronic transition that can be accessed through light, thermal, or electrical excitation. Ultrafast optical studies of this insulator-to-metal transition indicate that it is mediated by the formation of a transient metallic phase that retains the structure of the original insulating phase. Sood *et al.* show that a similar sequence

occurs when the material is electrically excited with a series of voltage pulses. Using ultrafast electron diffraction, the researchers monitored the structure of a vanadium dioxide sample after excitation and found evidence of a metastable metallic phase that appears during the transition. —JS

*Science*, abc0652, this issue p. 352

## NEUROSCIENCE

### Conserved spatial memory mechanisms

Food-caching birds are memory specialists that can remember thousands of hidden food items. Using electrophysiological recordings from freely behaving birds, Payne *et al.* analyzed neuronal activity in the likely hippocampus homolog of two bird species, the tufted titmouse and the zebra finch. They chose these two species to compare, respectively, birds that do and do not display food-caching behavior. Place cells and typical hippocampal firing patterns that resembled rodent neuronal activity could be detected in the extreme memory specialists. Compared with titmice, however, spatial activity was noticeably weaker and less abundant in zebra finches. These findings provide evidence that the neural processes



Conserved brain circuits enable spatial recall for seed-caching tufted titmice.

underlying spatial memory are remarkably conserved across widely divergent hippocampal circuits separated by millions of years of evolution. —PRS

*Science*, abg2009, this issue p. 343

## EMERGING INFECTIONS

### Correlates of protection

Vaccines against Ebola virus (EBOV) are difficult to test in humans because of the sporadic nature of EBOV outbreaks. Therefore, understanding correlates of protection in preclinical models is necessary. Meyer *et al.* tested five candidate mucosal EBOV vaccines in cynomolgus macaques and showed that, despite sharing the same EBOV glycoprotein as an antigen, they varied in their ability to protect animals from EBOV challenge. The authors interrogated correlates of protection and found that functional qualities of the antibody response were associated with protection. By contrast, neutralizing antibody titers did not correlate with survival. Thus, looking beyond the presence of neutralizing antibodies may be necessary to understand the protective effect of EBOV vaccines. —CSM

*Sci. Transl. Med.* **13**, eabg6128 (2021).

## NEUROSCIENCE

### Coordinated pause for plasticity

Protein synthesis and structural remodeling in dendritic spines mediate synaptic plasticity, the long-lasting changes in neuronal connectivity that underlie learning and memory. Mendoza *et al.* determined how these processes are coordinated. In mouse hippocampal neurons, glutamate-induced phosphorylation of the translation elongation factor eEF1A2 triggered its dissociation from its activator, thereby transiently inhibiting protein synthesis. This phosphorylation event also triggered the dissociation of eEF1A2 from actin fibers, thereby facilitating cytoskeletal remodeling. —LKF

*Sci. Signal.* **14**, eabf5594 (2021).

## IN OTHER JOURNALS

Edited by **Caroline Ash**  
and **Jesse Smith**



## PHYSIOLOGY

### Too hot to freeze

Embryonic sharks grow within external cases that are often translucent. In response to signs of predators, the embryos of several shark species become motionless (or “freeze”). The amount of time that they can remain still is limited by their need for oxygen exchange stimulated by their movement. Ripley *et al.* exposed small-spotted catshark embryos to water at 15° and 20°C, and found that the time they could remain motionless was reduced by sevenfold at the higher temperature. Although the precise mechanism was not clear, the authors conclude that this was in part a result of higher metabolic requirements at higher temperatures. Thus, the ability to “freeze” at higher temperatures may be compromised, leading to higher rates of predation in warmer oceans. —SNV

*Conserv. Physiol.* **9**, coab045 (2021).

A small-spotted catshark (*Scyliorhinus canicular*) embryo within its translucent egg case

## IMMUNOLOGY

**Regulating germinal center contraction**

Germinal centers (GCs) in secondary lymphoid organs are where mature B cells expand and differentiate. Although GC formation is well studied, the control of GC duration and contraction is less well understood. Using intravital imaging of mouse GCs and single-cell RNA sequencing, Jacobsen *et al.* report that T follicular helper ( $T_{FH}$ ) cells are a critical player in this process. They found that some late-GC  $T_{FH}$  cells upregulate the transcription factor FOXP3 and acquire a regulatory T cell–like phenotype. These cells are distinct from T follicular regulatory ( $T_{FR}$ ) cells and, unlike  $T_{FR}$  cells, are needed to shut down the GC reaction. Tweaking this process may be key to extending GC lifetimes and enhancing antibody responses in the context of vaccination. —STS

*Science*, abe5146, this issue p. 297

## MICROBIOLOGY

**Cleansing the cytosol**

Most human cells, not just those belonging to the immune system, mount protective responses to infection when activated by the immune cytokine interferon-gamma (IFN- $\gamma$ ). How IFN- $\gamma$  confers this function in nonimmune cells and tissues is poorly understood. Gaudet *et al.* used genome-scale CRISPR/Cas9 gene editing to identify apolipoprotein L-3 (APOL3) as an IFN- $\gamma$ -induced bactericidal protein that protects human epithelium, endothelium, and fibroblasts against infection (see the Perspective by Nathan). APOL3 directly targets bacteria in the host cell cytosol and kills them by dissolving their anionic membranes into lipoprotein complexes. This work reveals a detergent-like mechanism enlisted during human cell-autonomous

immunity to combat intracellular pathogens. —SMH

*Science*, abf8113, this issue p. 296;  
see also abj5637, p. 276

## DEVELOPMENTAL BIOLOGY

**Reconstituting the ovarian follicle**

Recent advances have enabled the generation of oocytes from pluripotent stem cells in vitro. However, these cells require a somatic environment to develop fully as reproductive cells. Yoshino *et al.* applied what is known about differentiation processes in vivo to determine a culture condition to differentiate embryonic stem cells into gonadal somatic cell–like cells (see the Perspective by Yang and Ng). When the embryonic stem cell–generated ovarian gonadal tissue was combined with early primordial germ cells or in vitro–derived primordial germ cell–like cells, germ cells developed into viable oocytes within the reconstituted follicles that could be fertilized and result in viable offspring. This system enables an alternative method for mouse gamete production and advances our understanding of mammalian reproduction and development. —BAP

*Science*, abe0237, this issue p. 298;  
see also abj8347, p. 282

## CORONAVIRUS

**Added value of PCR testing for COVID-19**

During the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic, polymerase chain reaction (PCR) tests were generally reported only as binary positive or negative outcomes. However, these test results contain a great deal more information than that. As viral load declines exponentially, the PCR cycle threshold (Ct) increases linearly. Hay *et al.* developed an approach for extracting epidemiological

information out of the Ct values obtained from PCR tests used in surveillance for a variety of settings (see the Perspective by Lopman and McQuade). Although there are challenges to relying on single Ct values for individual-level decision-making, even a limited aggregation of data from a population can inform on the trajectory of the pandemic. Therefore, across a population, an increase in aggregated Ct values indicates that a decline in cases is occurring. —CA

*Science*, abh0635, this issue p. 299;  
see also abj4185, p. 280

## ZEOLITE CHEMISTRY

**Fencing in radicals**

Zeolite catalysis could potentially offer a more direct route from methane to methanol. However, current catalysts tend to deactivate too quickly for practical use. Snyder *et al.* investigated the deactivation mechanism using Mössbauer and Raman spectroscopy and accompanying simulations (see the Perspective by Scott). Their results suggest that in zeolites with large apertures, after iron active sites strip hydrogen from methane, the resulting methyl radicals can leak away and deactivate other iron centers. Zeolites with tighter apertures can keep the radicals nearby longer, favoring the formation of methanol. —JSY

*Science*, abd5803, this issue p. 327;  
see also abj4734, p. 277

## NANOMATERIALS

**Shape and nanocrystal transformations**

Cation exchange reactions that change the composition of a nanocrystal (NC) under mild conditions usually preserve the sublattice of the larger anions. Li *et al.* found that the shape of roxbyte ( $Cu_{18}S$ ) nanocrystals, which have a distorted, hexagonal, close-packed sulfide

anion sublattice, affected the outcome of exchange reactions with cobalt ions. Flat nanoplates retained the anion lattice and formed cobalt sulfide, but tall nanorods transformed into  $Co_9S_8$  nanocrystals with a cubic, close-packed structure. Facile crystal plane sliding in the taller nanocrystals appears to have driven the different layer stacking of sulfide anions. —PDS

*Science*, abh2741, this issue p. 332

## MATERIALS SCIENCE

**Piezoelectric bioorganic thin films**

Piezoelectric materials enable a reversible conversion between mechanical pressure and electric charge and are useful for sensors, actuators, and high-precision motors. Yang *et al.* developed a method for making high-quality crystalline thin films of piezoelectric  $\gamma$ -glycine crystals that are grown and refined between layers of polyvinyl alcohol (PVA) (see the Perspective by Berger). The PVA layers are essential to promoting the crystallization of the preferred crystal phase with the polar axis oriented perpendicular to the film plan because of hydrogen bonding at the PVA-glycine interface. The thin films show a macroscopic piezoelectric response and high stability in aqueous environments. The films are water soluble and, when suitably packaged, could be implanted into a biodegradable energy-harvesting device. —MSL

*Science*, abf2155, this issue p. 337;  
see also abj0424, p. 278

## SOCIAL INHERITANCE

**Mother knows best**

Inheritance of social status, and its associated costs and benefits, is well demonstrated in humans. Whether such an intergenerational system occurs in other species is harder to demonstrate. Ilany *et al.* looked

at nearly 30 years of social interaction data in spotted hyenas, a female-dominated system with a highly structured society, and found that status inheritance is just as prominent (see the Perspective by Firth and Sheldon). Juvenile hyenas had social associations that were similar to their mothers, and the strength of the association was higher for higher-status mothers. Importantly, survival was associated with social inheritance, suggesting that these social roles are essential to hyena life. —SNV

*Science*, abc1966, this issue p. 348; see also abj5234, p. 274

## BIOMATERIALS

### A venom-inspired hemostatic bioadhesive

Bioadhesives can reduce surgery times and complications but their efficacy is reduced in the presence of significant bleeding. Guo *et al.* describe a blood-resistant hemostatic surgical bioadhesive that efficiently clots blood and seals severely injured tissues and organs. The gelatin-based bioadhesive incorporates reptilase, a pro-coagulant enzyme derived from snake venom, and can be activated on demand where it is needed using visible light. Their results suggest that photocurable reptilase-containing hemostatic bioadhesives may be effective for treating noncompressible bleeding tissues. —GAA

*Sci. Adv.* 10.1126/abf9635 (2021).

## TUMOR IMMUNOLOGY

### Unleashing immune cells in tumors

Conventional type 1 dendritic cells (cDC1s) perform specialized roles in antitumor immunity by processing and presenting tumor antigens that prime tumor-specific T cell responses. Using a mouse model of immunogenic tumor growth and single-cell transcriptomics, Ghislat *et al.* found that cDC1s require nuclear factor  $\kappa$ B signaling for their intratumoral

maturation into antitumoral cDC1s capable of recruiting and activating tumor-specific T cells. A kinase controlled the expression of a transcription factor that regulates interferon-mediated gene expression, and loss of either factor in cDC1 impaired their maturation and antitumoral immunity. These results highlight key molecular pathways involved in the development of full-fledged cDC1 capable of stimulating antitumoral T cell responses and suggest potential therapeutic targets for improving intratumoral DC function. —CO

*Sci. Immunol.* 6, eabg3570 (2021).

## MATERIALS SCIENCE

### The benefits of being repellent

The accumulation of foreign substances on a surface, whether it is dirt on a window or ice on an airplane wing, can lead to hazardous conditions. Many surfaces have been engineered to resist the accumulation of one type of fluid or matter in a particular state, but engineering broader resistivity has remained a challenge. For example, surfaces that repel water droplets may still be susceptible to fog accumulation. Dhyan *et al.* review the wetting performance and fouling resistance of different liquid-repellent coatings, focusing on superhydrophobic, superomniphobic, lubricant-infused, and liquid-like surfaces. Two key aspects are the performance of the surface to different foulants and the relevance of considering different length scales. —MSL

*Science*, aba5010, this issue p. 294

## CORONAVIRUS

### Senescent cells exacerbate COVID-19

Cellular senescence is a state elicited in response to stress signals and is associated with a damaging secretory phenotype. The number of senescent cells increases with advanced age and this in turn drives age-related diseases. Camell *et al.* show that

senescent cells have an amplified inflammatory response to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (see the Perspective by Cox and Lord). This response is communicated to nonsenescent cells, suppressing viral defense mechanisms and increasing the expression of viral entry proteins. In old mice infected with a SARS-CoV-2-related virus, treatment with senolytics to reduce the senolytic cell burden reduced mortality and increased antiviral antibodies. —VV

*Science*, abe4832, this issue p. 295; see also abi4474, p. 281